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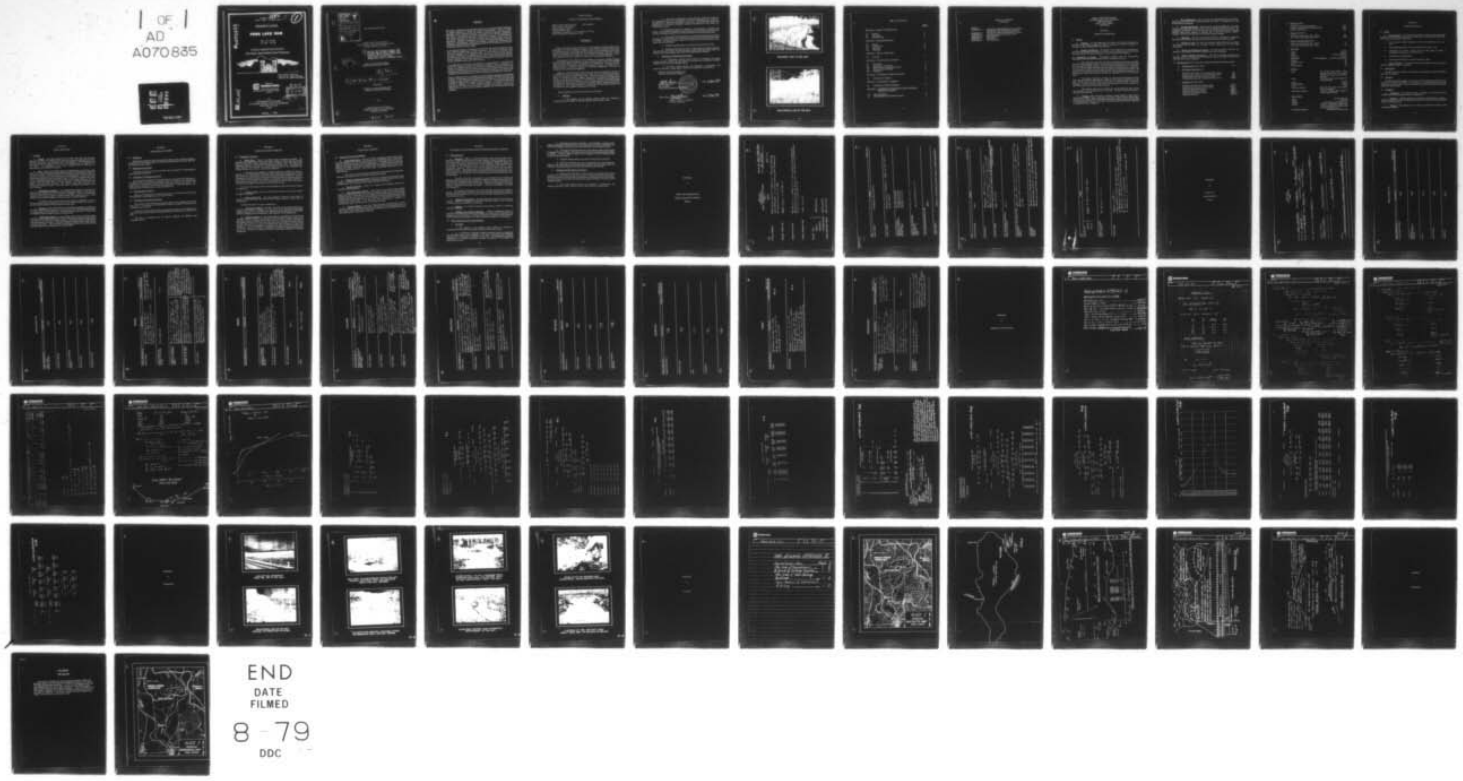

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DELAWARE RIVER BASIN
WRIGHT CREEK, LUZERNE COUNTY

AD A070835

PENNSYLVANIA

PENN LAKE DAM

NDI-PA 00542
PA DER 40-28

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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Contract No. DACW31-79-C-0010

Prepared By
O'BRIEN & GERE
Justin & Courtney Division
PHILADELPHIA, PENNSYLVANIA
19103

FOR
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

MARCH 1979

DELAWARE RIVER BASIN

Name of Dam: Penn Lake Dam
County & State: Luzerne County, Pennsylvania
Inventory Number: PA 00542

(6) National Dam Inspection Program. Penn Lake Dam (NDI ID Number PA-00542, DER ID Number 40-28), Delaware River Basin, Wright Creek, Luzerne County, Pennsylvania. Phase I Inspection Report.

(11) Mar 79

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

(12) 70 p.

(15) DACW31-79-C-0010

Prepared by:

O'BRIEN & GERE ENGINEERS, INC.
JUSTIN & COURTNEY DIVISION

For:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, MD 21203

410 760

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Penn Lake Dam ID # PA 00542
State Located: Pennsylvania
County Located: Luzerne
Stream: Wright Creek
Coordinates: Latitude 41° 05.4', Longitude 75° 46.8'
Date of Inspection: December 14, 1979

ASSESSMENT

Penn Lake Dam, owned by Carolyn D. and Robert H. Raymond (Penn Lake Association), is an earth embankment approximately 350 feet long and 44 feet high at its maximum section. The spillway consists of twelve 42-inch diameter, 20-foot long pipes located approximately 1,000 feet left (looking downstream) of the dam. Earth swales on both sides of the battery of pipes function as auxiliary spillways. The 56 acre reservoir is used for recreation by members of the Penn Lake Association.

Examination of the results of the hydrologic and hydraulic analyses indicates that the spillway (pipes and swales) is capable of passing 48 per cent of the Probable Maximum Flood (PMF) without overtopping of the embankment. Failure of the dam would increase the hazard of loss of life downstream of the dam. The capacity of the spillway system is therefore classified as "Seriously Inadequate". The dam is considered to be unsafe (non-emergency).

Based on visual observations made during the date of the inspection, the dam is considered to be in poor condition. There are seeps and rust colored water along the toe of the downstream embankment slope. The entire region immediately downstream of the dam is swampy. Bulges, depressions and embankment sloughing are evident on the downstream slope of the embankment. There are cut brush, stumps, and debris over the entire downstream slope. The upstream slope of the embankment is covered with heavy brush and there is a depression (Plate 4, Appendix E) near the left abutment. The riprap protection on the upstream and downstream slopes of the embankment is poorly graded and sparse in many areas.

Recommendations and remedial measures are as follows:

a. Facilities

1. The capacity of the spillway system should be increased in accordance with the results of detailed hydrologic and hydraulic studies.

2. A subsurface investigation program should be initiated to determine the composition and in situ properties of the earth embankment and foundation materials and to determine the stability of the dam. The investigations should be supervised by a licensed professional engineer experienced in the design and construction of dams.

3. Piezometers should be installed in the boreholes to evaluate pore pressure development throughout the earth embankment and aid in determining the source of the seeps all along the toe of the downstream earth embankment slope.

4. The area at the downstream end of the reservoir drain system should be cleared of silt and debris. The drain system should then be appraised and repaired as needed. A means of positive closure at the upstream end of the reservoir drain system should be developed.

5. All brush, stumps, debris, etc. should be removed from the dam.

6. Decisions concerning the need to supplement the riprap protection, raise the top of the dam, and add additional spillway facilities, should await the results of the drilling program and further hydrologic/hydraulic analyses.

b. Operation and Maintenance Procedures

1. A downstream warning system should be developed; and during periods of heavy rainfall, the dam should be monitored and downstream residents alerted in the event of an impending failure.

2. The owner should develop and implement a maintenance and inspection checklist to insure that all items are maintained on a regular basis.

O'BRIEN & GERE ENGINEERS, INC.
JUSTIN & COURTNEY DIVISION

Will M. Heiser

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL WILL M. HEISER ENGINEER No. 6926E

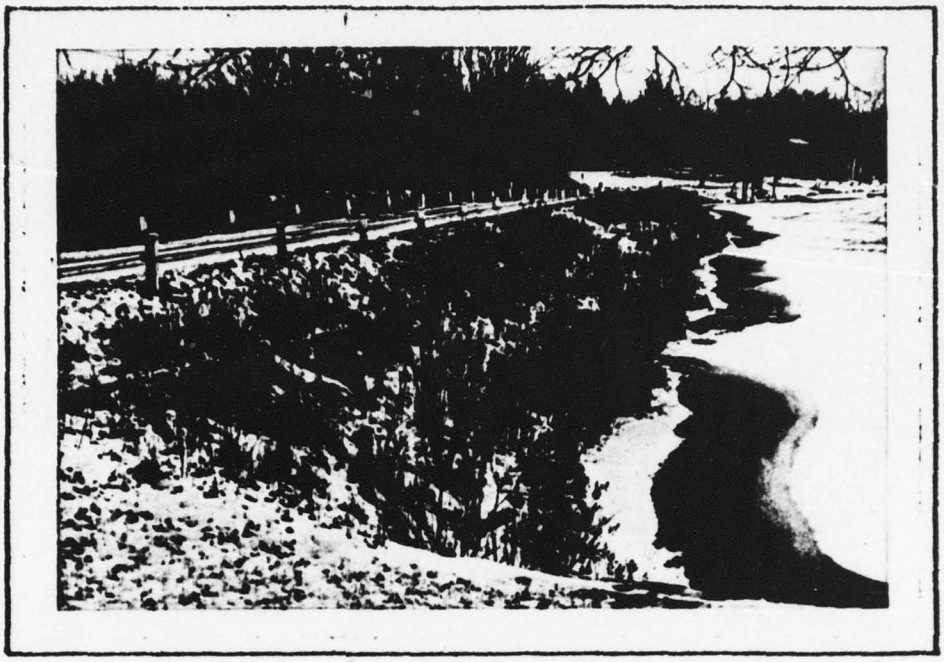
Will M. Heiser, P.E.
Vice-President
Pennsylvania Registration # 006926-E

Date: 16 Apr. 1979

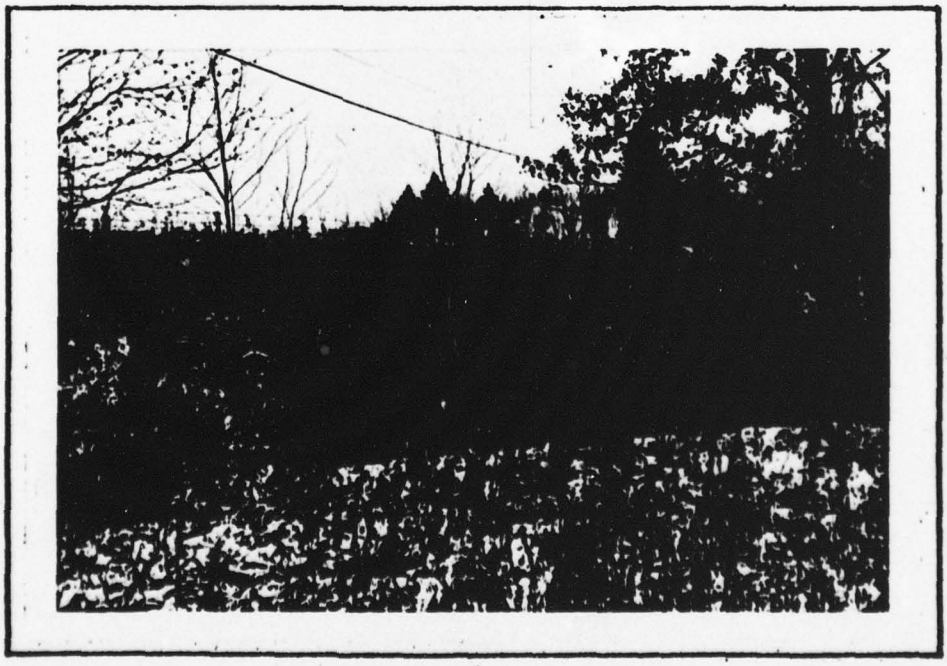
Approved by: G. R. Withers

G. R. WITHERS
Colonel, Corps of Engineers
District Engineer

Date: 14 May 1979



UPSTREAM VIEW OF THE DAM



DOWNSTREAM VIEW OF THE DAM

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(Continued)

PLATES

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
PENN LAKE DAM
NDI I.D. NO. PA-00542
DER #40-28

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose of Inspection. The purpose of this inspection is to evaluate the structural and hydraulic conditions of the Penn Lake dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project (Information obtained from the Pennsylvania Department of Environmental Resources (DER), Dam Safety Division)

a. Penn Lake Dam is an earth embankment, approximately 350 feet in length with a maximum height of 44 feet. The dam impounds a reservoir with a surface area of 56 acres and a storage capacity of 246 acre-feet at normal pool level. The top of the dam is 20 feet wide, the downstream side slope is approximately 1.75 horizontal to 1.0 vertical (1.75H:1V), and the upstream side slope is approximately 3H:1V. No information is available concerning the properties of the embankment materials. The upstream and downstream slopes of the dam are riprapped with 12 to 18 inches of stone.

The spillway consists of a battery of twelve, 42-inch diameter, 20-foot long, steel pipes located approximately 1,000 feet left (looking downstream) of the dam. Earth swales on both sides of the battery of pipes function as auxiliary spillways. The road, which is located around the perimeter of the lake, extends over the spillway pipes and across the top of the dam.

The reservoir drain system consists of a 36-inch steel pipe with a sluice valve located at the downstream toe of the dam. The sluice valve is housed in a concrete block structure.

b. Location. Penn Lake Dam is located on Wright Creek at a point about 4 miles north of White Haven, in Dennison Township, Luzerne County, Pennsylvania. The dam site is shown on the USGS Quadrangle entitled "White Haven, Pennsylvania" at coordinates N 41° 05.4, W 75° 46.8'. A regional location plan of Penn Lake Dam is enclosed as Plate 1, Appendix E.

c. Size Classification. Penn Lake Dam has a storage capacity of 80 million gallons (246 acre-feet) and a maximum height of 44 feet. The structure is in the intermediate size category.

d. Hazard Classification. There are about 12 private residences in the valley between Penn Lake Dam and the Lehigh River (a distance of about 2½ miles). The topography downstream of the dam is such that flood waters would be directed towards these homes resulting in probable loss of lives and extensive property damage. Therefore, the structure is in the "High" hazard category.

e. Ownership. The dam is owned by Carolyn J. and Robert H. Raymond (Penn Lake Association), Star Route Box 226, White Haven, Pennsylvania, 18661.

f. Purpose of Dam. The dam was originally built in 1905 for ice pondage. The reservoir is now used for recreation by the members of the Penn Lake Association.

g. Design and Construction History. The dam was built in 1905 by S.S. Staples for ice pondage. H.S. Smith of Wilkes Barre was the designer.

h. Normal Operating Procedures. The lake is normally maintained at Elevation 1333.0. The owner was not available to operate the reservoir drain sluice valve during the day of inspection.

1.3 Pertinent Data (From information supplied by Pennsylvania DER & USGS)

a. Drainage Area (square miles) 7.0

b. Discharge at Dam Site (cfs)

Reservoir drain system at normal pool Elev. 1333.0	130
Reservoir drain system at top of dam Elev. 1337.5	140
Ungated spillway at top of dam Elev. 1337.5	3,440
Total spillway capacity at top of dam Elev. 1337.5	3,580

c. Elevation (feet above MSL)

Spillway crest (normal, recreation pool)	1333.0
Top of dam (at low point of top of dam)	1337.5
Reservoir Drain Invert (inlet)	1299.0
Reservoir Drain Invert (outlet)	1298.0 ±
Streambed at centerline of dam	1298.0 ±
Maximum tailwater	1305.0 ±

d. Reservoir (miles)

Length of normal, recreation pool	0.61
Length of maximum non-overtopping pool	0.63
Fetch at normal pool	0.33

e. Storage (acre-feet)

Normal, recreation pool, Elev. 1333.0	246
Top of dam at low point, Elev. 1337.5	500

f. Reservoir Surface Area (acres)

Normal, recreation pool, Elev. 1333.0	56
Top of dam at low point, Elev. 1337.5	71

g. Dam Data

Type		Earth
Length		350 feet
Height		44 feet (maximum)
Top width		20 feet
Side Slopes	3H:1V (upstream);	1.75H:1V (downstream)
Zoning		No
Impervious core		No
Cutoff		No
Grout Curtain		No

h. Spillway

Type	12, 42-inch steel pipes. Earth swales on each side of the steel pipe spillway acts as an auxiliary spillway.
Width	42 feet at spring line of pipes plus swales 200 feet.
Length	20 feet
Crest elevation	1333.0±
Gates	None
Upstream channel	About 30 feet long, rock bottom, 2H:1V side slopes.
Downstream channel	Follows a natural draw through a heavily wooded region.

i. Outlet Works

Type	36-inch steel pipe
Length	230 feet ±
Closure	Sluice valve at downstream end.
Access	Intake is submerged; outlet structure and operating mechanism are at the downstream toe.
Regulating faciiities	Hand operated sluice valve.

SECTION 2

ENGINEERING DATA

2.1 Design

a. Data Available. The information available for review of Penn Lake Dam includes the following (all information obtained from the Pennsylvania DER main office files in Harrisburg, Pennsylvania):

1. Dam inspection reports beginning in 1912 and through the following years.

2. Photographs beginning in 1912 and through the following years.

3. "Application for Permit to Draw Dam or Other Body of Water in Accordance with the Act of 12-15-59", 1971.

4. Miscellaneous correspondence.

5. Sheet showing shoreline of reservoir prepared in 1949.

b. Design Features. The design features are discussed in Section 1.2.a and shown on Plates 3, 4, and 5 of Appendix E.

2.2 Construction

The dam was built in 1905 by S.S. Staples for ice pondage. H.S. Smith of Wilkes Barre was the designer.

2.3 Operation

Operation procedures appear to be limited to those necessary to draw down the reservoir by means of the sluice valve located in a concrete block shed at the downstream toe of the dam. There is no evidence that operating procedures have been written for this structure.

2.4 Evaluation

a. Availability. Very limited material is available. The one sketch of the impoundment area is enclosed as Plate 2 in Appendix E.

b. Adequacy. Although design and construction information is minimal, a Phase I evaluation is considered reasonable based on the revealing conditions observed during the field inspection.

c. Validity. There appears to be no reason to question the validity of the limited data available.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of the Penn Lake Dam took place on December 14, 1978. The reservoir water surface elevation was approximately 1333.0 during the inspection. No underwater areas were inspected. The observations and comments of the field inspection team are in the checklist which is Appendix B of this report. The appearance of the facility indicates that the dam and its appurtenances are marginally maintained.

b. Dam. There are numerous bulges and depressions of more than a foot which form an undulating pattern along both the upstream and downstream slopes and the top of the dam. A survey revealed that the top of the dam elevation varies as much as 4.5 feet along the 350-foot length of the embankment. There is also some embankment sloughing on the downstream slope. It is difficult to appraise the extent of the undulations, sloughing, and what is left of the riprap facing on both the upstream and downstream slopes of the dam because of cut trees and debris on the slopes. There are seeps and murky rust colored water along the toe of the downstream embankment slope. The entire region immediately downstream of the dam is swampy.

c. Appurtenant Structures. The spillway,which consists of a battery of twelve 42-inch diameter, 20-foot long pipes, located approximately 1,000 feet left (looking downstream) of the dam, is seriously inadequate. There are no trashracks upstream of the spillway pipes to prevent debris from reducing the flow. Earth swales on both sides of the battery of pipes function as auxiliary spillways.

The sluice valve of the reservoir drain system is assumed to be in a partially opened position judging from the amount of water flowing in the vicinity of the concrete block structure which houses the sluice valve.

d. Reservoir. Area reconnaissance of the reservoir disclosed no evidence of excessive siltation, slope instability, or other features that would significantly affect the storage capacity of the reservoir. The slopes along the perimeter of the reservoir are vegetated and on gradients of less than ten per cent.

e. Downstream Channel. For about 80 per cent of the 2.5 miles from Penn Lake Dam to the Lehigh River, Wright Creek flows through a heavily wooded region. The balance of the distance is through meadows. There is one highway bridge about 2 miles downstream of the dam. The channel gradient averages about 1.4 per cent for the entire 2.5 miles. There are about a dozen homes within the potential damage area along Wright Creek downstream of Penn Lake Dam.

SECTION 4

OPERATIONAL FEATURES

4.1 Procedures

Operational procedures have been covered in Section 1.2.h. Written operating procedures were not made available. Normal operating procedures for this structure do not require a dam tender.

4.2 Maintenance of the Dam

Attempts to contact the owner of the dam were unsuccessful. The dam appears to be marginally maintained.

4.3 Maintenance of Operating Facilities

No operating mechanism for the sluice gate was visible during the inspection. It is assumed that any operating mechanism would be housed in the inaccessible concrete block structure at the downstream end of the reservoir drain conduit. The sluice valve is maintained by the Penn Lake Association. Further discussion of the maintenance of the sluice valve is covered in Section 2.3.

4.4 Warning System in Effect

There is no evidence that a formal warning system or procedures to be followed during periods of exceedingly heavy rainfall is in effect.

4.5 Evaluation of Operational Adequacy

The operation and maintenance procedures appear to be marginal for the Penn Lake Dam. An operation and maintenance check list should be developed and implemented by the owner.

A formal warning system should be implemented because of the probability of loss of life and extensive property damage downstream in the event of a failure of the dam.

The dam is accessible under all weather conditions for inspection and emergency action.

SECTION 5

HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. There is no original design information available. The drainage area contributing to Penn Lake Dam is about 4.5 miles long and averages about 1.5 miles wide. Ground elevations range from 2060 to 1333. The slopes of the watershed adjacent to the reservoir are all less than ten per cent. The watershed is nearly 100 per cent wooded. The runoff characteristics of the watershed may undergo change in the future as a result of development.

The spillways are capable of handling a discharge of 3440 cfs. However, the SDF for this "Intermediate" size dam, with a "High" hazard classification, is the PMF which has a peak inflow of 7690 cfs and a peak outflow of 7630 cfs. The PMF hydrograph was routed through the reservoir with the starting water surface elevation at the crest of the spillway, Elev. 1333.0. The maximum water surface elevation in the reservoir resulting from the PMF routing would be 5.6 feet above the spillway crest and 1.1 feet above the lowest point of the top of the dam.

For further information, refer to the computations, data, and printouts included in Appendix C.

b. Experience Data. There is no evidence that rainfall or water level records are kept for this dam.

c. Visual Observations. The major spillway elements, which consist of twelve, 42-inch steel pipes and adjacent earth swales, showed no visible signs of deterioration.

Further observations are given in Appendix B.

d. Overtopping Potential. The SDF is the PMF for this "Intermediate" size, "High" hazard structure. Examination of the results of the hydrologic and hydraulic analysis indicates that the spillways are capable of passing 48 per cent of the PMF without overtopping of the embankment. (See Appendix C for computations).

e. Spillway Adequacy. A dam break analysis was performed to evaluate the increased "hazard to loss of life downstream from the dam from that which would exist just before overtopping failure" (ETL 1110-2-234, 10 May, 1978). According to the analysis, failure of the Penn Lake Dam during the occurrence of 50 per cent of the PMF would increase the depth of overbank flow from 3.0 feet to 5.2 feet in the hazard area. The peak discharge at the hazard area would increase from 3,860 cfs to 11,150 cfs. Failure of the dam is considered to significantly increase the hazard to loss of life. Therefore, the spillway of the Penn Lake Dam is classified as "seriously inadequate".

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. There are surface undulations of more than a foot along the top of the dam and the side slopes of the embankment which could be the result of settlement or poor construction methods. The riprap facing on both the upstream and downstream slopes of the embankment is obscured by the cut trees and debris on the slopes. Seeps and rust colored water are evident along the toe of the downstream embankment slope. The entire region immediately downstream of the dam is swampy.

Due to the lack of information concerning the embankment and foundation materials, the stability of the dam cannot be properly assessed.

b. Design and Construction Data. There are no design and construction data available. It is known that the structure was originally designed in 1905 by H.S. Smith of Wilkes Barre and it was built by S.S. Staples during the same year.

c. Operating Records. There is no evidence that operating records are maintained at this structure.

d. Post Construction Changes. Since there are no records of the original design and construction, there is no way of knowing exactly what constituted the original structure. Sometime after the original construction, the dam was increased in height from 24 feet to 44 feet, and the spillway was developed approximately 1,000 feet left (looking downstream) of the dam. There is no documentation of when these modifications were made. From the DER files, information is available on maintenance repair work done on the dam through the years.

e. Seismic Stability. Penn Lake Dam is located in Seismic Zone 1 of the "Seismic Zone Map of Contiguous States". Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected Zone 1 earthquake conditions.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Evaluation. Based on visual observations made during the date of the inspection, the dam is considered to be in poor condition. There are seeps and murky rust colored water evident along the toe of the downstream embankment slope. The entire region immediately downstream of the dam is swampy. Bulges and depressions are evident on the downstream slope of the embankment and there is some embankment sloughing. There are cut brush, stumps, and debris over the entire downstream slope. The upstream slope of the embankment is covered with heavy brush and there is a depression (Plate 4, Appendix E) near the left abutment. The riprap protection on the upstream and downstream slopes is poorly graded and sparse in many areas.

The SDF is the PMF. Examination of the results of the hydrologic and hydraulic analysis indicates that the spillway is capable of passing 48 per cent of the PMF without overtopping of the embankment. Failure of the dam would increase the hazard to loss of life downstream of the dam. Therefore, the capacity of the drop spillway is classified as "seriously inadequate". The dam is considered to be unsafe (non-emergency).

It is assumed the sluice valve of the reservoir drain system is partially opened. This observation is based on the amount of water flowing in the vicinity of the concrete block structure at the toe of the downstream embankment slope which houses the sluice valve.

b. Adequacy of Information. Although design and construction information is minimal, a Phase I evaluation is considered reasonable based on the revealing conditions observed during the field inspection.

c. Urgency. The remedial measures recommended in Section 7.2 should be effected immediately.

d. Necessity for Further Evaluation. Further investigation should be performed to determine the source of the seeps, rust colored water, undulations, and sloughing of the embankment. Detailed hydrologic and hydraulic studies should be made to determine the necessity to increase the spillway system for this structure.

7.2 Recommendations and Remedial Measures

a. Facilities.

1. The capacity of the spillway system should be increased in accordance with the results of detailed hydrologic and hydraulic studies.

2. A subsurface investigation program should be initiated to determine the composition and in situ properties of the earth embankment and foundation materials and to determine the stability of the dam. The investigations should be supervised by a licensed professional engineer experienced in the design and construction of dams.

3. Piezometers should be installed in the boreholes to evaluate pore pressure development throughout the earth embankment and aid in determining the source of the seeps all along the toe of the downstream earth embankment slope.

4. The area at the downstream end of the reservoir drain system should be cleared of silt and debris. The drain system should then be appraised and repaired as needed. A means of positive closure at the upstream end of the reservoir drain system should be developed.

5. All brush, stumps, debris, etc. should be removed from the dam.

6. Decisions concerning the need to supplement the riprap protection, raise the top of the dam, and add additional spillway facilities, should await the results of the drilling program and further hydrologic/hydraulic analyses.

b. Operation and Maintenance Procedures

1. Because there are about a dozen homes located along Wright Creek between Penn Lake Dam and the Lehigh River (a distance of about $2\frac{1}{2}$ miles), a downstream warning system should be developed, and during periods of heavy rainfall, the dam should be monitored and downstream residents alerted in the event of an impending failure.

2. The owner should develop and implement a maintenance and inspection checklist to insure that all items are maintained on a regular basis.

APPENDIX

A

Check List Engineering Data

Design, Construction, Operation

Phase I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Penn Lake Dam

ID # PA 00542

ITEM	REMARKS
AS-BUILT DRAWINGS	There are no "As-Built" drawings. The only drawing in the DER files is a sheet showing the shoreline of the reservoir prepared 2/49
REGIONAL VICINITY MAP	Refer to Appendix E, Plate 1
CONSTRUCTION HISTORY	The dam was built in 1905 by S.S. Staples and his associates for the purpose of securing ice pondage. The structure was designed by H.S. Smith Wilkes Barre, Pa.
TYPICAL SECTIONS OF DAM	Not Available
OUTLETS - PLAN	Not Available
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	Not Available
RAINFALL/RESERVOIR RECORDS	Not Available

ITEM	REMARKS
DESIGN REPORTS	No design data available.
GEOLOGY REPORTS	None provided in DER files. Refer to Appendix F of this report.
DESIGN COMPUTATIONS	No data available
HYDROLOGY & HYDRAULICS	No data available
DAM STABILITY	No data available
SEEPAGE STUDIES	No data available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	No information available
POST-CONSTRUCTION SURVEYS OF DAM	None
BORROW SOURCES	There is no record of where borrow material came from.

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	Sometime after the original construction the dam was increased in height from 24' to 44' There is no documentation of when this was done. Spillway was developed approx. 1000 ft. left of the dam sometime after the original construction
HIGH POOL RECORDS	None available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Letter written 12/29/11 warns of impending failure of the site This led to state inspection of the dam and remedial repairs in 1912
MAINTENANCE OPERATION RECORDS	Correspondence through the years (from DER files) gives information about sporadic maintenance work that was done on the structure. There are no operating records available.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	Refer to Appendix E for details
OPERATING EQUIPMENT PLANS & DETAILS	No information available
MISCELLANEOUS	Material in DER files: 1. Dam inspection reports through the years. 2. Photographs related to the structure from 1912 through 1965 3. "Application for Permit to Draw Dam or other Body of Water" (1971) 4. Miscellaneous correspondence 5. Sheet showing shoreline of reservoir prepared 1949.

APPENDIX

B

Check List

Visual Inspection

Phase I

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam Penn Lake Dam County Luzerne State Pennsylvania National ID # PA-00542

Type of Dam Earth Fill Hazard Category High

Date(s) Inspection Dec 14, 1978 Weather Cloudy, Cold Temperature ≈ 20°F

Pool Elevation at Time of Inspection 1333 + M.S.L. Tailwater at Time of Inspection 1290 ± M.S.L.

Inspection Personnel:

George A. Elias David B. Campbell Leonard R. Beck

Leonard R. Beck Recorder

Remarks:

We were not successful in contacting anyone associated with the dam.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	N/A	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N/A	
DRAINS	N/A	
WATER PASSAGES	N/A	
FOUNDATION	N/A	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N/A	
STRUCTURAL CRACKING	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT	N/A	
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	N/A	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Could not tell because there is so much cut trees and debris on the slopes and a hard surface road runs along the top of the dam	clean all of the cut trees and debris off the slopes of the dam
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	None
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	There appears to be sloughing especially on the downstream slope. It is difficult to tell how much sloughing has occurred, because there is so much cut trees and debris on the slopes	A boring program should be initiated to determine the composition and in situ properties of the embankment and foundation materials & to determine the stability of the dam
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	There are numerous bulges and depressions which form an undulating pattern along both the upstream and downstream slopes and the top of the dam	Piezometers should be installed in the bore holes to evaluate pore pressure development throughout the embankment
RIPRAP FAILURES	It is difficult to tell what is left of the riprap facing on both the upstream and downstream faces because of the cut trees and debris on the slopes.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	It is difficult to assess the situation at the junction of the embankment and abutment because of the excessive debris and brush on the slopes. The spillway is about 1000 feet left of the embankment	refer to comments on sheet 4/11
ANY NOTICEABLE SEEPAGE	There is seepage of varying degrees all along the downstream toe	refer to comments on sheet 4/11 . Consideration should be given immediately to foundation and embankment grouting &/or a completely new internal drainage system.
STAFF GAGE AND RECORDER	None	None
DRAINS	None observed	None

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet conduit could not be observed.	Draw down impoundment so that entire reservoir drain system can be examined.
INTAKE STRUCTURE	Intake structure could not be observed because it was under water.	"
OUTLET STRUCTURE	Outlet of reservoir drain system could not be observed because it was inside a locked concrete block structure.	"
OUTLET CHANNEL	It meanders through the woods for about 300 feet where it joins the channel for the spillway discharge	Could be realigned to flow directly away from the dam.
EMERGENCY GATE	It is assumed the sluice valve is in a permanently open position judging from the amount of water flowing in the vicinity of the concrete block structure which houses the gate.	sluice valve should be examined and repaired as needed.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Weir is actually the invert of 12, 42 inch, 20 feet long pipes. The invert of the pipes ≈ Elev. 1333.0 A road is built on top of the pipes. The surface of the road is about 5 feet above the pipe invert	This spillway is of very limited capacity Swales on both sides of spillway pipes act as auxiliary spillways
APPROACH CHANNEL	Approach channel is only about 30 feet in length with limited obstruction from timber bridge	"
DISCHARGE CHANNEL	Follows natural draw through heavily wooded region. Channel gradient is on about a 2 percent slope.	Timbered draw presents too much of an obstruction to flow
BRIDGE AND PIERS	Timber bridge (pedestrian traffic) and highway culvert (12, 42-inch, 20-foot long pipes).	Restricts flow, needs to be opened up.

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	N/A	
OBSERVATION WELLS	N/A	
WEIRS	N/A	
PIEZOMETERS	N/A	
OTHER	N/A	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	All slopes are less than 10%. Entire shoreline of reservoir is residentially developed.	None
SEDIMENTATION	Probably won't be too much additional sediment accumulation because the entire shoreline is residentially developed. A certain amount of sediment probably was deposited in the reservoir when all the structures were built around the lake.	None

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	For about 80% of the 2.5 miles from Penn Lake Dam to the Lehigh River Wright Creek flows through a heavily wooded region. The balance of the distance is through meadows. There is one highway bridge about 2.0 miles downstream of Penn Lake Dam.	An estimated "n" value is about 0.06 for the entire 2.5 miles
SLOPES	The channel gradient averages about 1.4% for the entire 2.5 miles from Penn Lake Dam to the confluence of Wright Creek with the Lehigh River.	None
APPROXIMATE NO. OF HOMES AND POPULATION	there are about a dozen homes and approximately 60 people.	A formal warning system should be developed and implemented. Procedures for evacuating people within the potential flood area should be implemented.

APPENDIX

C

Hydrologic & Hydraulic Data

O'BRIEN & GERE
ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
Penn Lake Dam				

Table of Contents APPENDIX C

Hydraulics & Hydrologic Data

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
PENN LAKE DAM	1	RRB	3/5/79	

✓ 3/6/79

HYDROLOGY CALCS.

DRAINAGE AREA: 7.0 SQUARE MILES

PMP CALCULATIONS (HMS REPORT 33)

AREA IS IN ZONE 1

24 HR., 200 SQ. MI. RAINFALL = 22"

HR.	%	RAINFALL	ΔRF
6	111	24.4"	24.4"
12	123	27.1"	2.7"
24	133	29.3"	2.2"
48	142	31.2"	1.9"

SNYDER COEFFICIENTS

FROM INFO. PROVIDED BY COE, FOR THE DELAWARE RIVER BASIN, ZONE 2:

$$C_p = 0.45$$

AND $C_t = 2.1$

$$t_p = C_t (L \cdot L_{ca})^{0.3}$$

$L \cong 5.3$ miles $\qquad L_{ca} \cong 2.8$ miles

$$t_p = 2.1 (5.3 \cdot 2.8)^{0.3} = 4.72 \text{ HR.}$$

O'BRIEN & GERE ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
Penn Lake Dam, Stage vs. Discharge	2	[illegible]	2/23/79	

✓RLS 3/5/79

12 Spillway Pipes

Pipe Flow Assume Pipe Invert El. 1333.0 (Normal Pool)

@ El. 1334.5 (Approx. low point of swales)

ES 97, 3/7 (SCS, NEH-5)

For 1.50' of H_2O in a 3.5' pipe $\frac{d}{D} = \frac{1.5}{3.5} = 0.43$

For Normal Discharge

$$\frac{n\,Q_{n.d}}{D^{8/3}\,S_o^{1/2}} = 0.178$$

$$Q_{n.d} = \frac{0.178}{n} D^{8/3} S_o^{1/2}$$

Assume $D = 3.5'$, $S_o = 0.01\%$, $n = 0.015$

$$Q_{n.d} = \frac{0.178 \times 3.5^{8/3} \times 0.01^{1/2}}{0.015} = 33.7 \text{ cfs} \approx 34 \text{ cfs}$$

For 12 pipes 34 × 12 = 408 cfs.

Full Pipe Flow

$$Q_p = C_p H_p^{1/2} \qquad C_p = A_p \sqrt{\frac{2g}{1 + K_e + K_o + K_p L_p}}$$

$K_e \approx 1.0$ (Entrance loss coeff. culvert)

$K_o \approx 0.5$ (Exit loss coeff. culvert)

$K_p = 0.00784$ (pipe friction coeff.) (ES 42 SCS)

L_p = Length of pipe

$A_p = 9.62 \times 12 = 115.44$ (42" ⌀ pipe)

Assume invert outlet @ El. 1332.8

$$C_p = 115.44 \sqrt{\frac{64.4}{1 + 1.0 + 0.5 + 0.00784 \times 20}}$$

$$C_p = 568.4$$

With H_2O @ El. 1337.5 in reservoir

$Q_p = 568.4 \times 2.95^{1/2}$

$Q_p = 977$ cfs

With H_2O @ El. 1340.0 in reservoir

$Q_p = 568.4 \times 5.45^{1/2}$

$Q_p = 1327$ cfs.

Discharge Through Swales

Right Side Swale

H_2O to El. 1337.5 & Swale Invert El. 1334.5

Find equivalent rect. X-sec. of flow

Dimensions (Ft)		X-Sec. Area (Ft²)
$\frac{3 \times 48}{2}$	=	72
$50 \left(\frac{3 + 2.7}{2}\right)$	=	142.5
$\frac{2.7 \times 102}{2}$	=	137.1
		351.6 Ft²
		÷ 3 Ft (depth) ≈ 118 Ft width of flow

Left Side Swale

H_2O to El. 1337.5 & Swale Invert El. 1334.5

Dimensions (Ft)		X-Sec. Area (Ft²)
$\frac{3 \times 43}{2}$	=	64.5
$25 \left(\frac{2.5 + 3}{2}\right)$		68.8
$\frac{2.5 \times 48}{2}$		60.0
		$\frac{193.3}{3}$ ≈ 64 Ft. width of flow

O'BRIEN & GERE ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
Upper Lake Dam, Stage th. Discharge	3	[illegible]	2/22/79	

✓ RRL 3/5/79

Discharge Through Surface & Over Spillway Weir

Right Side Sluice

H_2O to El. 1340.0 & Sluice Invert El. 1334.5

Dimensions (Ft.)	X-Sec. Area (Sq. Ft.)
$\frac{2.4+5.5}{2} \times 50$	= 197.5
$\frac{5.5+5.2}{2} \times 50$	= 267.5
$\frac{5.2 \times 19.5}{2}$	= 507.0
	$\frac{972.0}{5.2} \approx 194$ Ft.

Left Side Sluice

H_2O to El. 1340.0 & Sluice Invert El. 1334.5

Dimensions (Ft.)	X-Sec. Area (Sq. Ft.)
$\frac{2+5.5}{2} \times 50$	= 187.5
$\frac{5.5+5}{2} \times 48$	= 131.2
$\frac{5 \times 96}{2}$	= 240.0
	$\frac{558.7}{5.5} \approx 102$ Ft.

Flow Over Spillway Piers

H_2O to El. 1340.0 & El. Surface Over Piers = El. 1333.0 ± El. 1332.6

Use H = 2.2', Width of Spwy. System 50'

Flow Over Top of Dam

H_2O to El. 1340.0 Less El. Top of Dam El. 1337.4

$\frac{2.3 \times 41}{2}$	= 54.0
$\frac{2.3+2.6}{2} \times 50$	= 122.5
$\frac{2.6+1.1}{2} \times 50$	= 92.5
$\frac{1.1+2.5}{2} \times 50$	= 40.0
$\frac{0.5 \times 16}{2}$	= 4.0
	$\frac{313.0}{2.6} \approx 120$ Ft.

O'BRIEN & GERE ENGINEERS, INC.

SUBJECT: Penn Lake Dam, Stage vs. Discharge | SHEET: 4 | BY: [illegible] | DATE: [illegible] | JOB NO:

✓RLB 3/5/79

Elev	Spillway Pipes Invert el 1333.0		Swale Left of Dam Invert 1334.5 3/		Swale Right of Dam [illegible] 3/		Flow over [illegible] Pipes 3/		Flow over Dam 3/		Total Q (Rounded to nearest 10 cfs)
	H	Q	H	Q	H	Q	H	Q	H	Q	
1333.0	0	0									0
1334.5	1.5	408 1/	0	0	0	0					410
1337.5	4.5	977 2/	3.0 4/	865	3 5/	1595	0	0	0	0	3440
1340.0	7.0	1327 2/	5.5 6/	3421	5.5 7/	5936	2.2 8/	679	2.6 9/	1303	12670

1/ Refer to Sh 2

2/ Refer to Sh 2

3/ Broad crested coeff. of $C = 2.60$ used in formula $Q = CLH^{3/2}$

4/ $L = 64'$, refer to Sh 2

5/ $L = 118'$, refer to Sh 2

6/ $L = 102'$, refer to Sh 3

7/ $L = 177'$, refer to Sh 3

8/ Ave. H over spwy. pipes, $L = 80'$, refer to Sh 3

9/ $L = 120'$, refer to Sh 3

O'BRIEN & GERE ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
Reno Lake Dam, Stage Vs. Storage	5	JL	2/22/79	

Stage	Surface Area (Ac.)	Storage (Ac.-Ft.)
1293	0	0
1333 1/	56	246 2/
1340	84	736
1360	168	2416

1/ Normal reservoir surface elevation taken from USGS White Haven, Pa. 7½' Quadrangle

2/ Storage capacity supplied by DER (according to gal = 24 Ac.-Ft.)

Reservoir Outlet Discharge

$$C_p = k_p \sqrt{\frac{2g}{1 + k_e + k_o + k_p L_p}}$$

$$C_p = 7.07 \sqrt{\frac{2g}{1 + 0.5 + 0.017 \cdot 230}}$$

$$C_p = 7.07 \times 3.16$$

$$C_p = 22.34$$

$k_p = 7.07$ ft$^{1/2}$

$n = 0.020$ (very old pipe, assume interior of very smooth)

$k_e = 0.5$ (Entrance loss coeff.)

$k_o = 1.0$ (Exit loss coeff.)

$k_p = 0.0171$ (pipe loss coeff, ES-42 SCS)

$L_p = 230'$

Reservoir invert outlet = Elev. 1298.0

Top of dam @ max. at El. 1341.9
use El. 1342.0

Reservoir @ gate valve = Elev. 1239.5

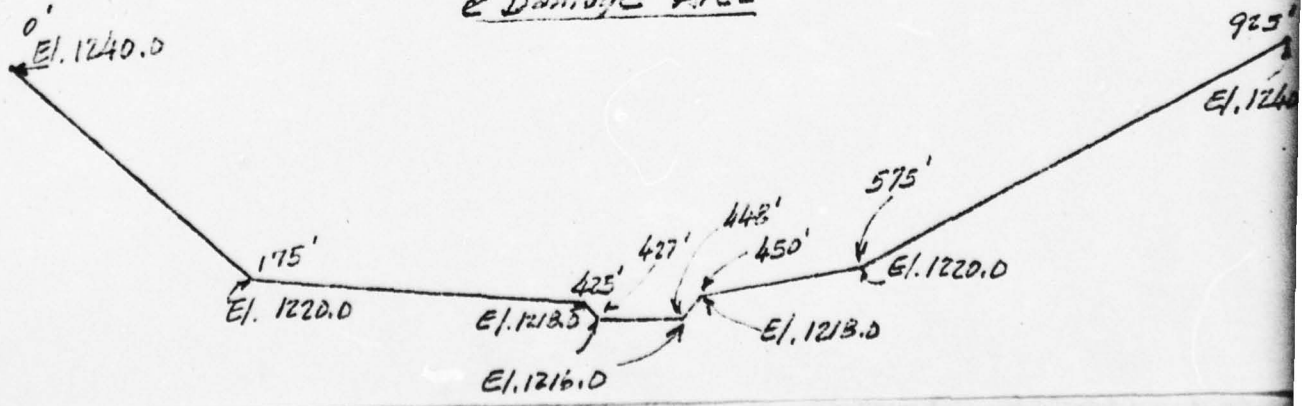
With normal pool @ El. 1333.0
head @ @ gate valve = 1333.0 - 1299.5
= 33.5

$$Q_p = C_p H_p^{1/2}$$

$$Q_p = 22.34 \times 33.5^{1/2}$$

$$Q_p = 129.3 \quad \text{USE } 130 \text{ cfs}$$

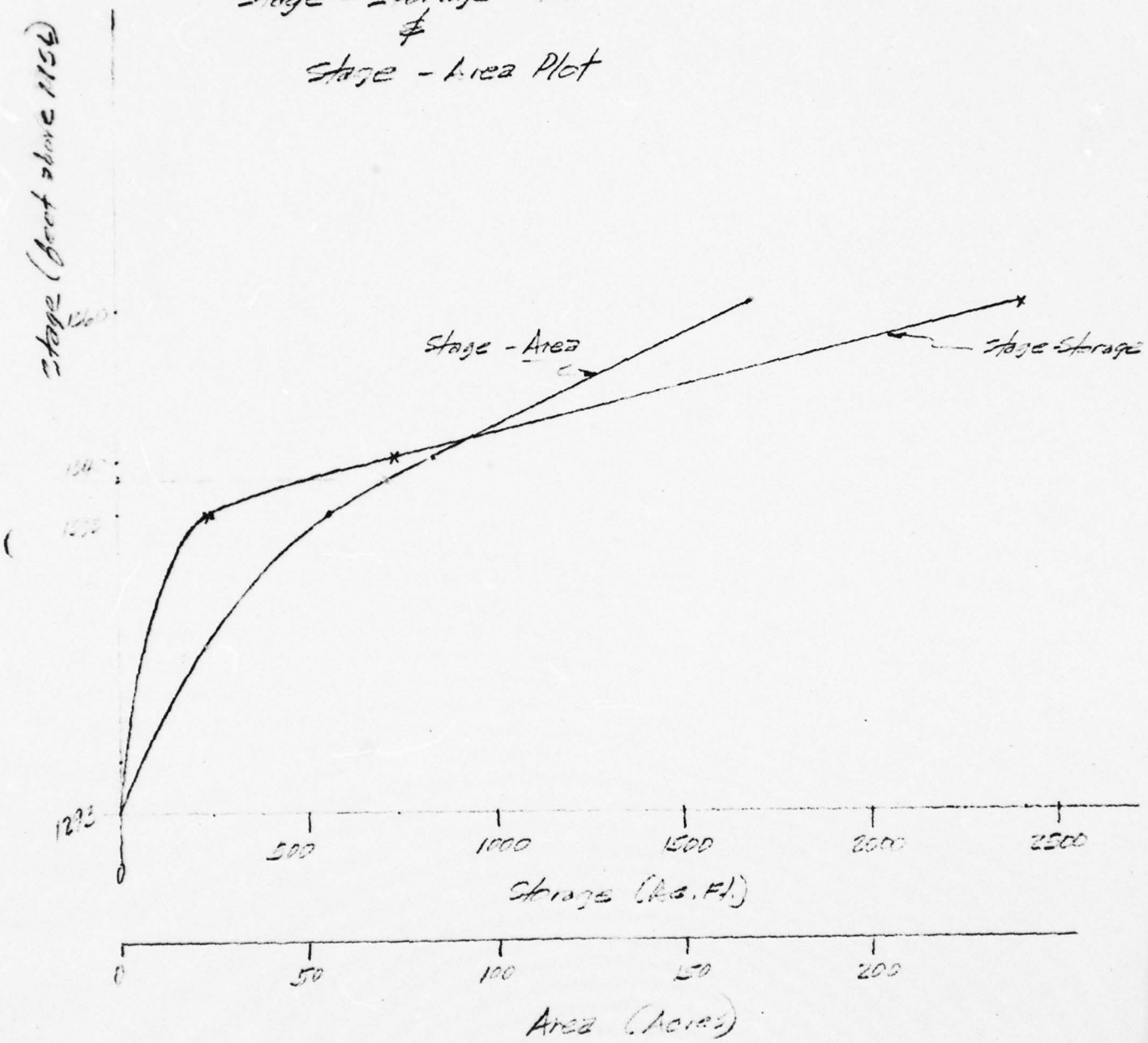
Cross-Section Downstream @ Damage Area



O'BRIEN & GERE ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
Remi Lake Dam	6	[illegible]	2/28/74	

Stage - Storage Plot
&
Stage - Area Plot



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**************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
LAST MODIFICATION [illegible]
**************************************

 1   [illegible]                          NATIONAL DAM INSPECTION PROGRAM
 2   [illegible]                                    PENN LAKE DAM
 3   A3                                             PMF HYDROGRAPH
 4   [illegible]  150     1      0      0      0      0      0      0     -4      0
 5   [illegible]    5
 6   J        1      9      1
 7   J1     .20    .30    .40    .50    .60    .70    .80    .90   1.00
 8   [illegible]    0     A1                                   1
 9   [illegible]                        RUNOFF TO RESERVOIR
10            1      1    7.0
11   [illegible]    0     22    111    123    133    142
12   T                                                   1.0   0.05
13   [illegible] [illegible]  0.45
14   [illegible] -1.5   -.05      2
15   [illegible] [illegible]   A2                                   1
16   [illegible]                        ROUTING THROUGH PENN LAKE
17   [illegible]                               1      1
18   [illegible]    1                                   -1333     -1
19   [illegible] 1333  1334.5 1337.5   1340   1350
20   [illegible]    0    410   3440  12600 150000
21   [illegible]    0    240    730   2410
22   [illegible] [illegible]  1333   1340   1360
23   [illegible] 1333
24   [illegible] 1337.4
25   [illegible]
```

Sh 1

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****************************************
FLOOD HYDROGRAPH PACKAGE  (HEC-1)
DAM SAFETY VERSION          JULY 1978
  LAST MODIFICATION [illegible] 78
****************************************

RUN  DATED 03/[illegible]/7[illegible].
     TIME  0[illegible].[illegible].[illegible].

                         NATIONAL DAM INSPECTION PROGRAM
                                 PENN LAKE DAM
                                 PMF HYDROGRAPH

                              JOB SPECIFICATION
      NO     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
     150       1       0       0       0       0       0       0      -4       0
                           JOPER     NWT   LROPT   TRACE
                               5       0       0       0

                      MULTI-PLAN ANALYSES TO BE PERFORMED
                        NPLAN= 1 NRTIO= 9 LRTIO= 1
   RTIOS=    .20     .30     .40     .50     .60     .70     .80     .90    1.00

**********          **********          **********          **********          **********

                            SUB-AREA RUNOFF COMPUTATION

                              RUNOFF TO RESERVOIR

                  ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                    A1       0       0       0       0       0       1       0       0

                                  HYDROGRAPH DATA
         IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
             1      1    7.00    0.00    7.00    0.00   0.000       0       0       0

                                    PRECIP DATA
                 SPFE     PMS      R6     R12     R24     R48     R72     R96
                 0.00   22.00  111.00  123.00  133.00  142.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                                    LOSS DATA
      LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
          0    0.00    0.00    1.00    0.00    0.00    1.00    1.00     .05    0.00    0.00

                               UNIT HYDROGRAPH DATA
                         TP=  4.72     CP= .45     NTA=  0

                                 RECESSION DATA
                   STRTQ=   -1.50     QRCSN=    -.05     RTIOR= 2.00

  UNIT HYDROGRAPH 44 END-OF-PERIOD ORDINATES, LAG=   4.73 HOURS, CP=  .45   VOL= 1.00
      [illegible]   135.    265.    377.    424.    402.    353.    310.    272.    238.
      [illegible]   153.    161.    141.    124.    109.     95.     84.     73.     64.
      [illegible]    90.     43.     38.     33.     29.     26.     23.     20.     17.
      [illegible]    13.     12.     10.      9.      8.      7.      6.      5.      5.
       15.      4.      3.      3.
        4.
```

Sh 8

	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
			SUM	24.99	22.60	2.39	104788.
				(635.)	(574.)	(61.)	(2967.27)

Sh 9

HYDROGRAPH ROUTING

ROUTING THROUGH PENN LAKE

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A2	1	0	0	0	0	1	0	0

ROUTING DATA

WLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1333.	-1

STAGE	1333.00	1334.50	1337.50	1340.00	1350.00
FLOW	0.00	910.00	3440.00	12000.00	151000.00
CAPACITY=	0.	246.	736.	2416.	
ELEVATIONS=	1333.	1333.	1330.	1350.	

CREL	SPWID	COGW	EXPW	ELEVL	COOL	CAREA	EXPL
1333.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOL	EXPD	DAMWID
1337.4	0.0	0.0	0.

PEAK OUTFLOW IS 1471. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 2239. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 2786. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 3004. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 2714. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 2335. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 2130. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 2093. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 2034. AT TIME 45.00 HOURS

SH 10

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .30	RATIO 3 .40	RATIO 4 .50	RATIO 5 .60	RATIO 6 .70	RATIO 7 .80	RATIO 8 .90	RATIO 9 1.00
HYDROGRAPH AT	A1	7.00 (18.13)	1	1537. (43.53)(	2306. 65.30)(	3074. 87.06)(	3843. 108.83)(	4612. 130.59)(	5380. 152.36)(	6149. 174.12)(	6918. 195.89)(	7686. 217.65)
ROUTED TO	[illegible]	7.00 (18.13)	1	1491. (42.21)(	2234. 63.39)(	2986. 84.54)(	3904. 110.55)(	4714. 133.49)(	5338. 151.14)(	6136. 173.75)(	6885. 194.97)(	7634. 216.18)

Sh 11

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1333.00	1333.00	1337.40
STORAGE	246.	246.	561.
OUTFLOW	0.	0.	3440.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1335.37	0.00	426.	1491.	0.00	45.00	0.00
.30	1336.31	0.00	478.	2239.	0.00	45.00	0.00
.40	1337.05	0.00	530.	2986.	0.00	45.00	0.00
.50	1337.63	.13	570.	3904.	3.00	45.00	0.00
.60	1337.99	.35	595.	4714.	5.00	44.00	0.00
.70	1338.02	.52	597.	5338.	7.00	45.00	0.00
.80	1338.24	.74	613.	6136.	9.00	45.00	0.00
.90	1338.44	.94	627.	6885.	10.00	45.00	0.00
1.00	1338.64	1.14	641.	7634.	11.00		

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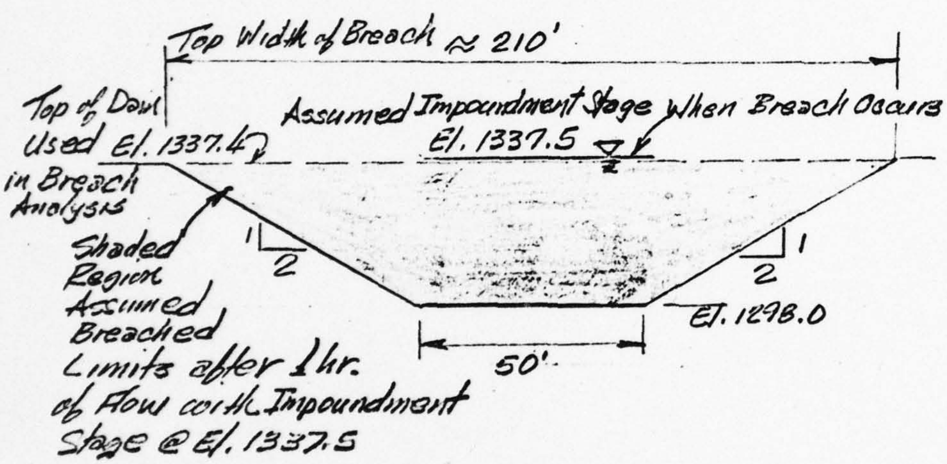
FLOOD HYDROGRAPH PACKAGE  (HEC-1)
DAM SAFETY VERSION        JULY 1978
LAST MODIFICATION      25 SEP 78
**********************************
A1                       NATIONAL DAM INSPECTION PROGRAM
A2                                PENN LAKE DAM
A3                                PMF HYDROGRAPH
H     300       0      10       0       0       0       0       0      -4       0
H1      5
J       2       1       1
J1    .50
K       0      A1                                       1
K1                              RUNOFF TO RESERVOIR
M       1       1     7.0                                                       1
P       0      22     111     123     133     142
T                                                     1.0    0.05
W    4.72    0.45
X    -1.5    -.05       2
K       1      A2                                       1
K1                          ROUTING THROUGH PENN LAKE
Y                               1       1
Y1      1                                           -1333      -1
Y4   1333  1334.5  1337.5    1340    1350
Y5      0     410    3440   12600  150000
$S      0     246     736    2416
$E   1293    1333    1340    1360
$$   1333
$D1337.4
$B     50       2    1298       1    1333    1360
$B     50       2    1298       1    1333  1337.5
K       1      B1                                       1
K1                              ROUTING DOWNSTREAM
Y                               1       1
Y1      1                                              -1
Y6    .08     .04     .08    1216    1240    7500    .012
Y7      0    1240     175    1220     425    1218     427    1216     448    1216
Y7    460    1218     575    1220     925    1240
K      99
```

0.5 PMF with Dam Break Sh 12



The portion of the dam assumed to be breached is based on the geometry of the site. The depth of flow over the top of the dam at which failure is initiated and the elapsed time to complete failure are based on the general appearance and age of the structure. Consideration was given to the parameters used in the C.O.E. publication "Basic Concepts of Dam Breaks and Development of Dam Break Hydrographs."

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 25 SEP 78
****

RUN DATED 03/19/79.
TIMED 07.40.40.

0.5 PMF with Dam Break Sh 13

NATIONAL DAM INSPECTION PROGRAM
PENN LAKE DAM
PMF HYDROGRAPH

JOB SPECIFICATION

NQ	NMH	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	10	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 2 NRTIO= 1 LRTIO= 1

RTIOS= .50

****

SUB-AREA RUNOFF COMPUTATION

RUNOFF TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	7.00	0.00	7.00	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.00	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 4.72 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 4.71 HOURS, CP= .45 VOL= .85

3.	10.	22.	35.	51.	68.	86.	106.	127.	149.
171.	194.	218.	243.	268.	293.	315.	337.	356.	374.
390.	404.	417.	428.	436.	443.	447.	448.	445.	437.
428.	418.	409.	400.	391.	383.	374.	366.	358.	350.
342.	335.	327.	320.	313.	306.	299.	293.	286.	280.
274.	268.	262.	256.	250.	245.	239.	234.	229.	224.
219.	214.	209.	205.	200.	196.	191.	187.	183.	179.
175.	171.	167.	164.	160.	157.	153.	150.	146.	143.
140.	137.	134.	131.	128.	125.	122.	120.	117.	115.
112.	110.	107.	105.	102.	100.	98.	96.	94.	92.

END-OF-PERIOD FLOW

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.99	22.60	2.39	414437.

Sh 14

0.5PMF with Dam Break

HYDROGRAPH ROUTING

ROUTING THROUGH PENN LAKE

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.000	0.000	0.000	-1333.	-1

STAGE	1333.00	1334.50	1337.50	1340.00	1350.00
FLOW	0.00	410.00	3440.00	12000.00	150000.00
CAPACITY=	0.	246.	736.	2416.	
ELEVATION=	1293.	1333.	1340.	1360.	

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1333.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1337.5	0.0	0.0	0.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	2.00	1298.00	1.00	1333.00	1360.00

PEAK OUTFLOW IS 3435. AT TIME 44.50 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	2.00	1298.00	1.00	1333.00	1337.50

BEGIN DAM FAILURE AT 43.67 HOURS

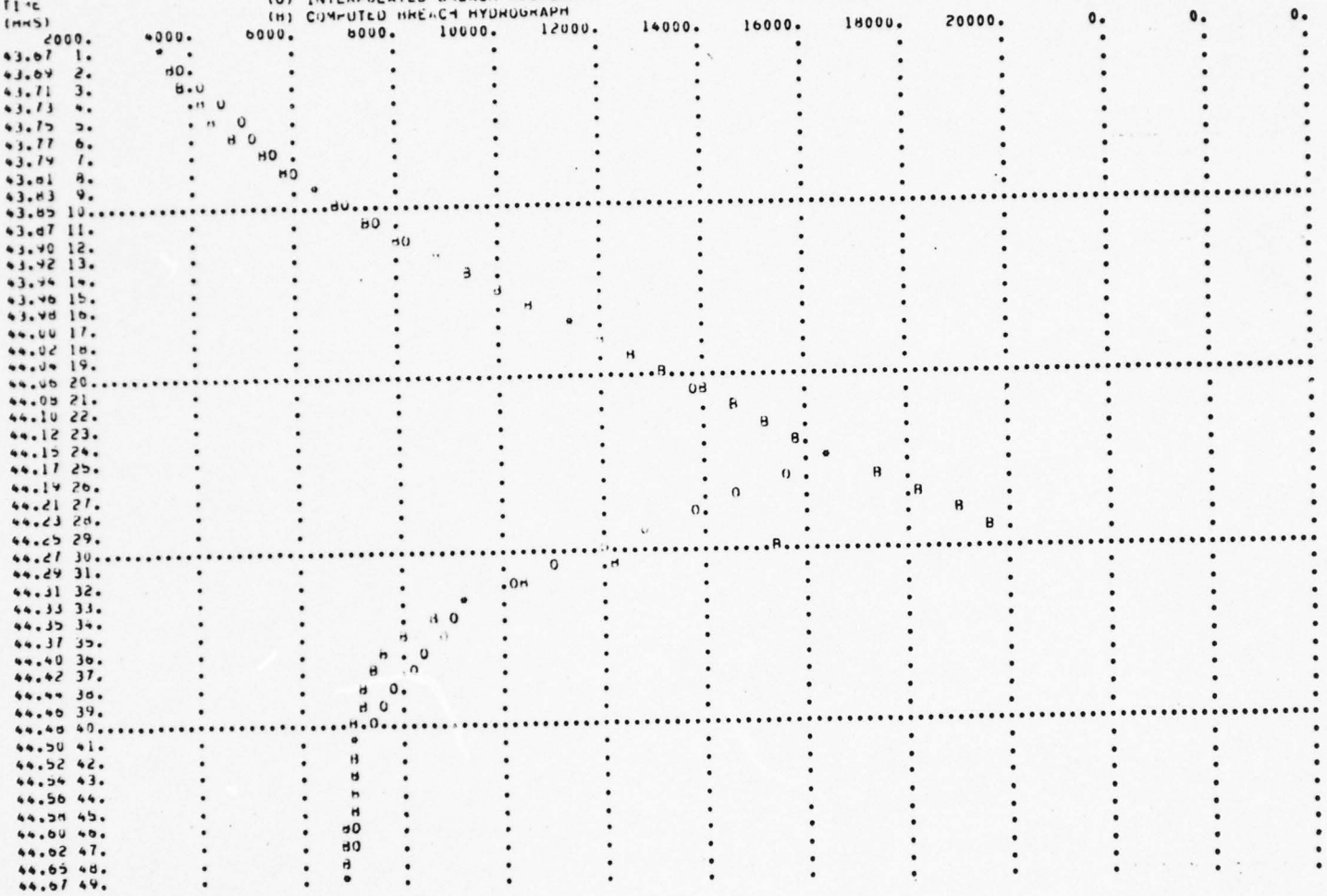
PEAK OUTFLOW IS 19673. AT TIME 44.25 HOURS

0.5PMF with Dam Break
Sh 15

OVF

STATION A2

(O) INTERPOLATED BREACH HYDROGRAPH
(B) COMPUTED BREACH HYDROGRAPH
(*) POINTS AT NORMAL TIME INTERVAL



DVN

•••••••••• •••••••••• •••••••••• •••••••••• ••••••••••

0.5PMF with Dam Break
Sh 16

HYDROGRAPH ROUTING

ROUTING DOWNSTREAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
81	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1216.0	1240.0	7500.	.01200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1240.00 175.00 1220.00 425.00 1218.00 427.00 1216.00 448.00 1216.00
450.00 1218.00 575.00 1220.00 925.00 1240.00

STORAGE	0.00	4.84	14.66	67.31	156.09	252.70	356.52	467.56	585.80	711.26
	843.92	983.80	1130.89	1285.19	1446.70	1615.42	1791.36	1974.51	2164.86	2362.43
OUTFLOW	0.00	125.55	432.46	1406.52	3875.17	7623.88	12509.41	18497.82	25580.75	33762.91
	43056.66	53479.16	65050.65	77793.66	91732.03	106890.74	123295.52	140972.58	159948.51	180250.13
STAGE	1216.00	1217.26	1218.53	1219.79	1221.05	1222.32	1223.58	1224.84	1226.11	1227.37
	1228.63	1229.89	1231.16	1232.42	1233.68	1234.95	1236.21	1237.47	1238.74	1240.00
FLOW	0.00	125.55	432.46	1406.52	3875.17	7623.88	12509.41	18497.82	25580.75	33762.91
	43056.66	53479.16	65050.65	77793.66	91732.03	106890.74	123295.52	140972.58	159948.51	180250.13

MAXIMUM STAGE IS 1221.0

MAXIMUM STAGE IS 1223.2

•••••••••• •••••••••• •••••••••• •••••••••• ••••••••••

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

0.5PMF with Dam Break
Sh 17

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS 1 .50
HYDROGRAPH AT	A1	7.00	1	3958.
		(18.13)		(112.08)(
			2	3958.
				(112.08)(
ROUTED TO	A2	7.00	1	3935.
		(18.13)		(111.43)(
			2	16488.
				(466.89)(
ROUTED TO	B1	7.00	1	3863.
		(18.13)		(109.38)(
			2	11152.
				(315.80)(

SUMMARY OF DAM SAFETY ANALYSIS

0.5 PMF with Dam Break
Sh 18

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1333.00	1333.00	1337.40
STORAGE	246.	246.	561.
OUTFLOW	0.	0.	3440.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1337.64	.24	570.	3935.	2.83	44.50	0.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1333.00	1333.00	1337.50
STORAGE	246.	246.	561.
OUTFLOW	0.	0.	3440.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1337.52	.12	563.	19673.	.25	44.25	43.67

PLAN 1 STATION B1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	3861.	1221.0	45.00

PLAN 2 STATION B1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	11156.	1223.2	44.33

APPENDIX

D

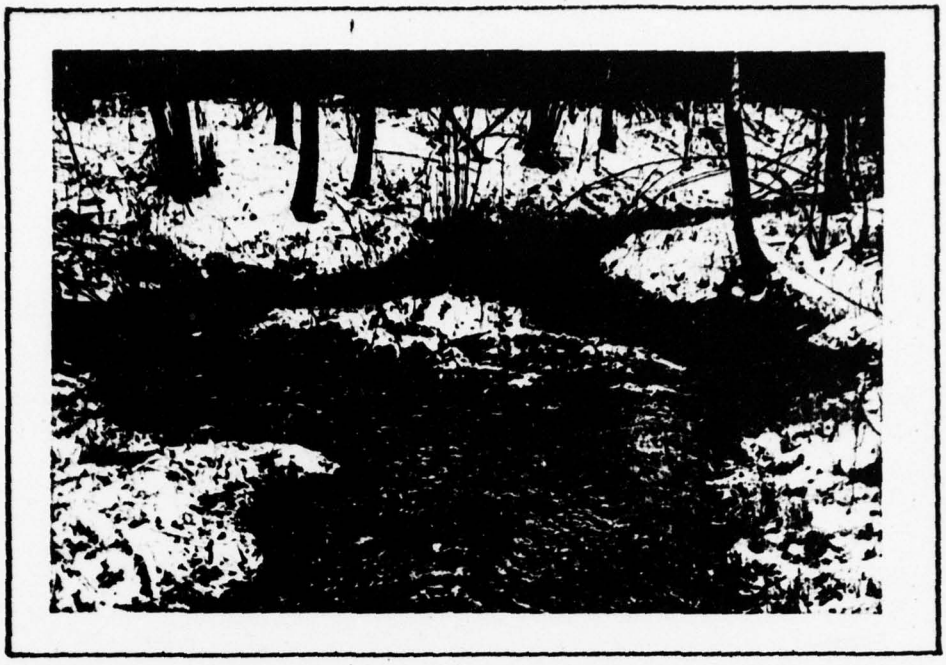
Photographs

VIEW OF THE RESERVOIR
FROM THE TOP OF THE DAM

DOWNSTREAM FACE OF THE DAM
SHOWING CUT BRUSH LEFT IN PLACE

VIEW FROM THE DOWNSTREAM FACE OF THE DAM SHOWING DISCHARGE FROM THE RESERVOIR DRAIN PIPE AND SEEPAGE

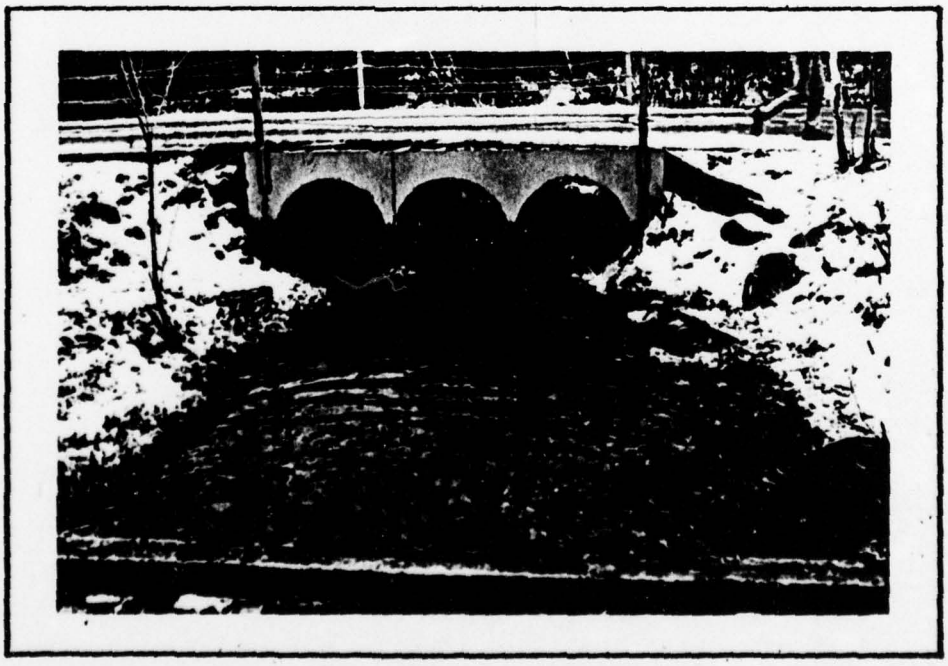
THE GATE VALVE SHELTER. DISCHARGE IS FROM THE RESERVOIR DRAIN PIPE AND SEEPAGE



APPROXIMATELY 10 C.F.S. DISCHARGE FROM RESERVOIR DRAIN PIPE AND SEEPAGE ABOUT 50 FEET DOWNSTREAM FROM THE DAM

DISCOLORED SEEPAGE FLOW IMMEDIATELY DOWNSTREAM OF THE DAM

CLOSE UP OF THE SEEPAGE FLOW
IMMEDIATELY DOWNSTREAM OF THE DAM



A PORTION OF THE SPILLWAY FLOW
ABOUT 1000 FEET TO THE LEFT OF THE DAM

APPENDIX

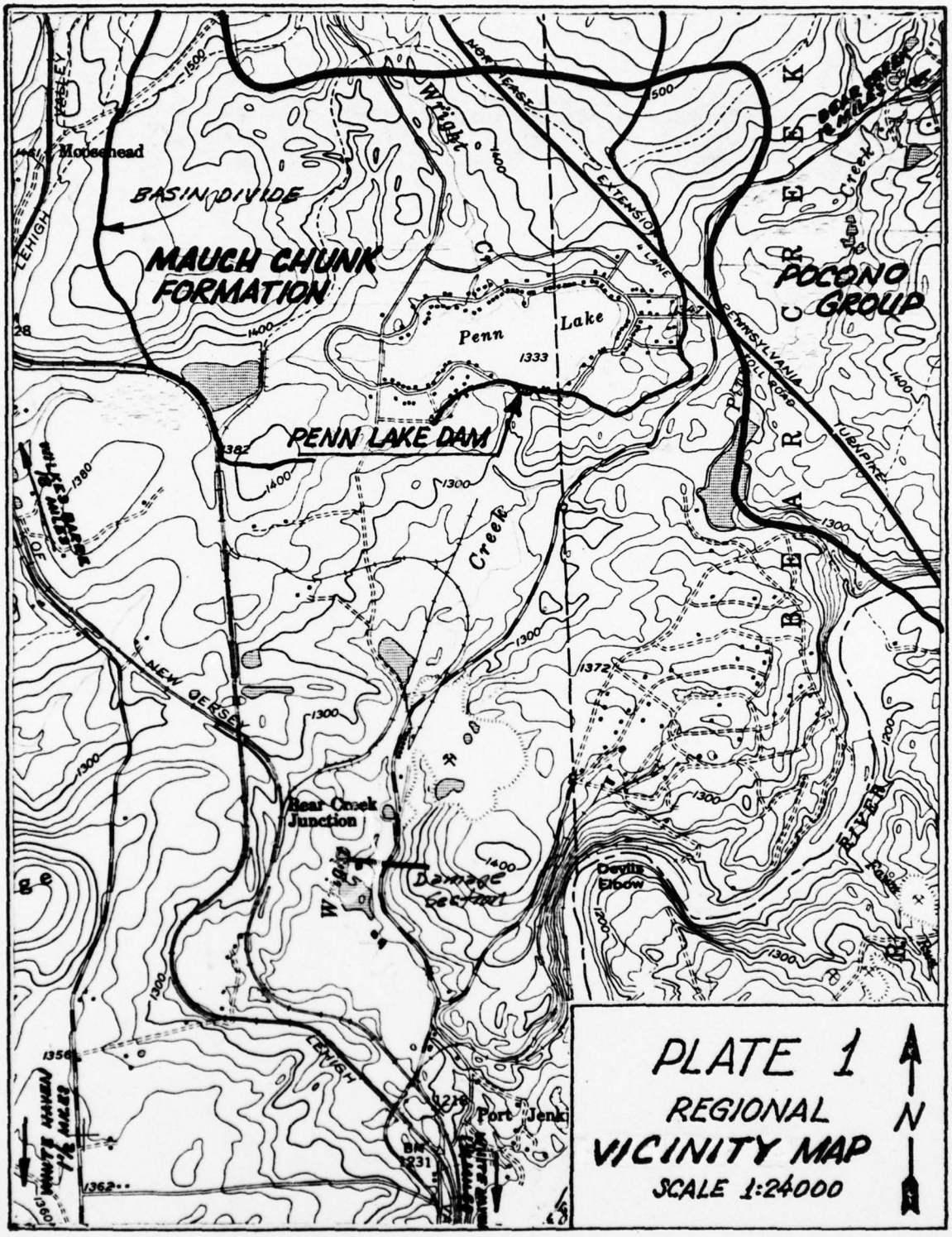
E

Drawings

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Penn Lake Dam			4/10/79	

Table of Contents APPENDIX E


Mooseheod
BASIN DIVIDE
MAUCH CHUNK FORMATION
LEHIGH
Wright Creek
EXTENSION
LANE
Penn Lake
1333
POCONO GROUP
PENNSYLVANIA TURNPIKE
PENN LAKE DAM
1382
Creek
BEAR
NEW JERSEY
Bear Creek Junction
Damage Section
Devils Elbow
RIVER
Port Jervis
BM 231
1362
PLATE 1
REGIONAL
VICINITY MAP
SCALE 1:24000
N

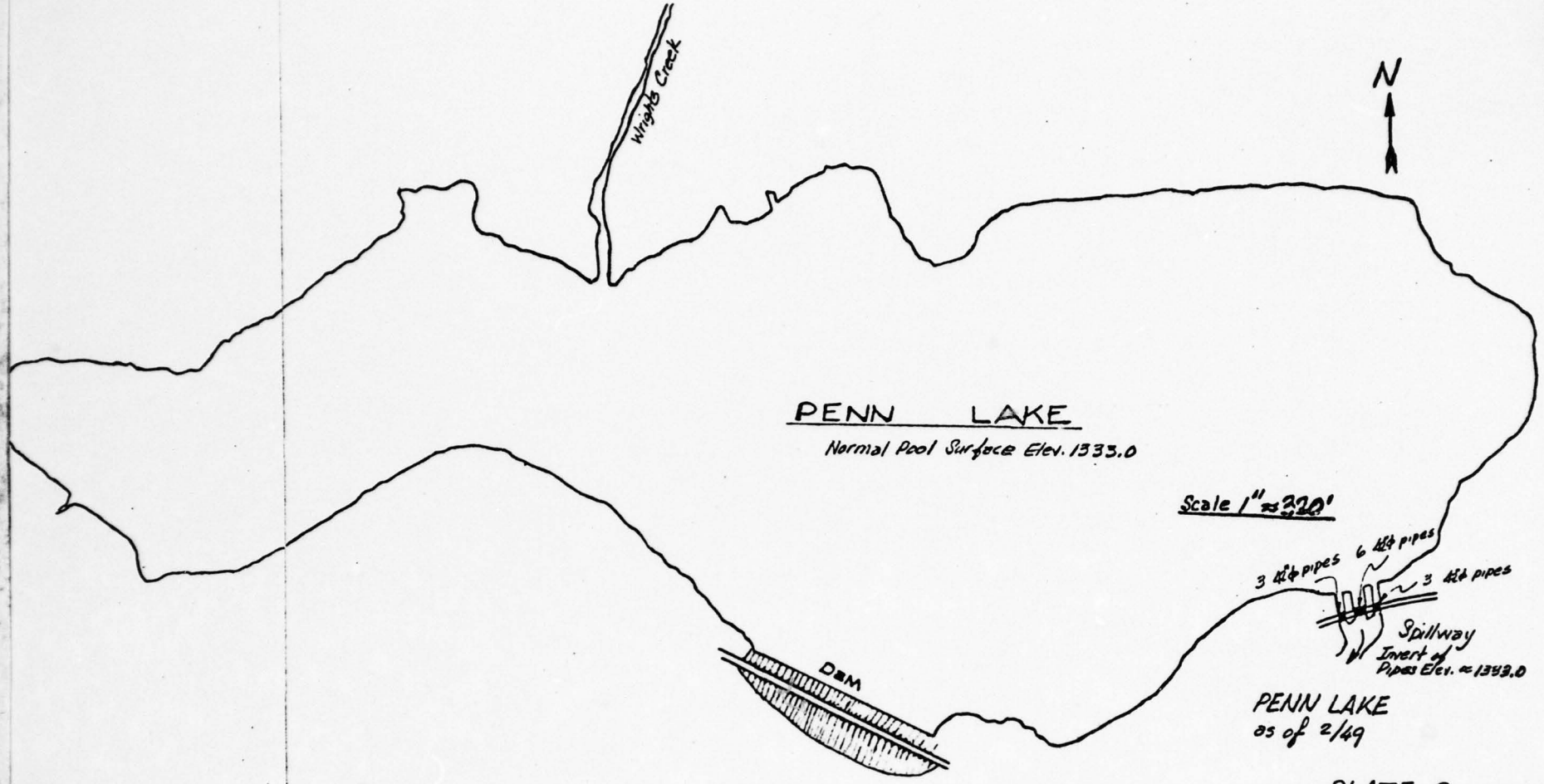
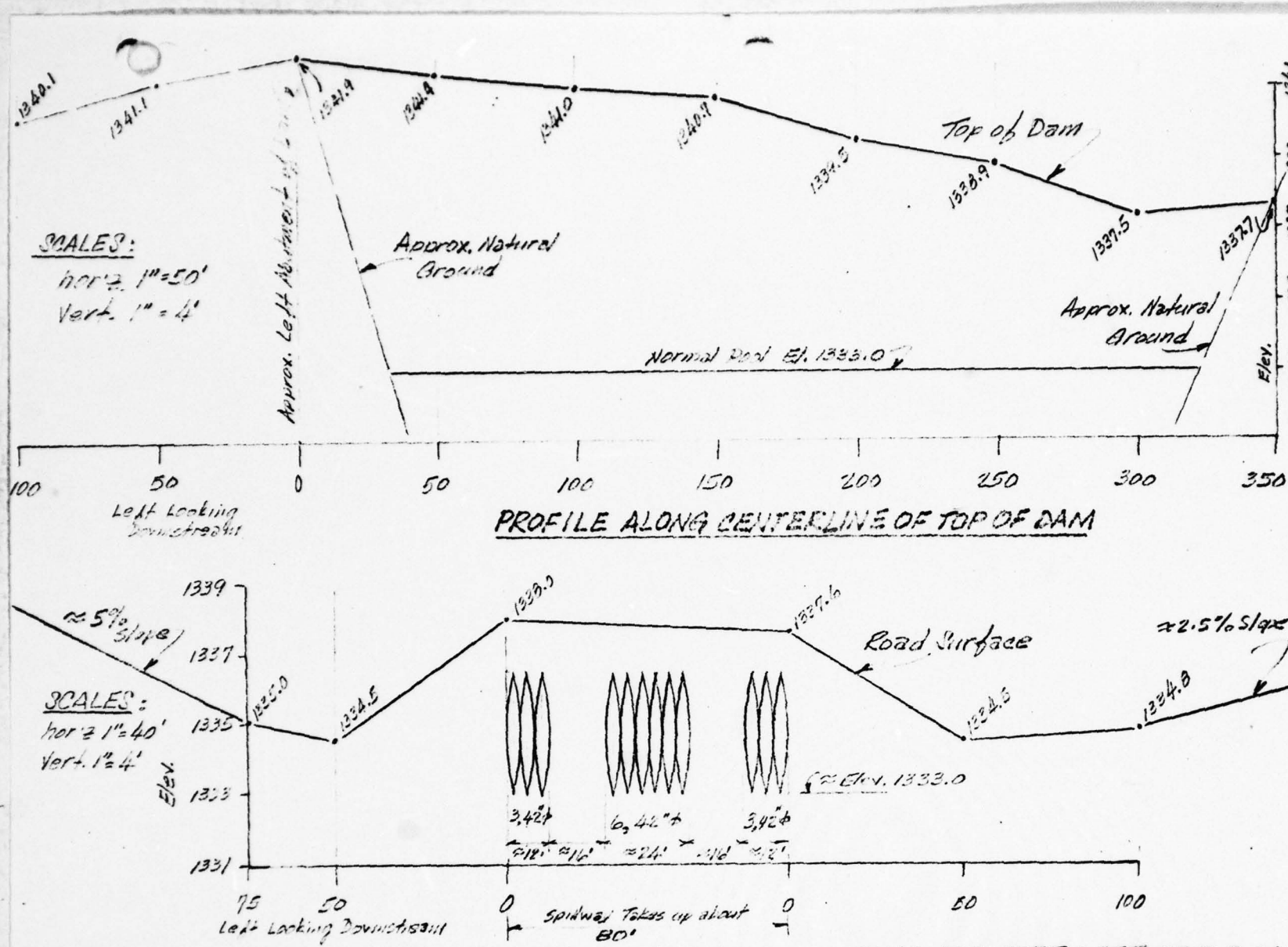

Wright's Creek
N
PENN LAKE
Normal Pool Surface Elev. 1333.0
Scale 1" = 320'
3 42" ϕ pipes
6 42" ϕ pipes
3 42" ϕ pipes
Spillway
Invert of Pipes Elev. = 1343.0
DAM
PENN LAKE
as of 2/49

PLATE 2



O'BRIEN & GERE ENGINEERS, INC.

SUBJECT: Reno Lake Dam, Dam & Spillway Profile

SHEET

BY: B

DATE: 2/21/74

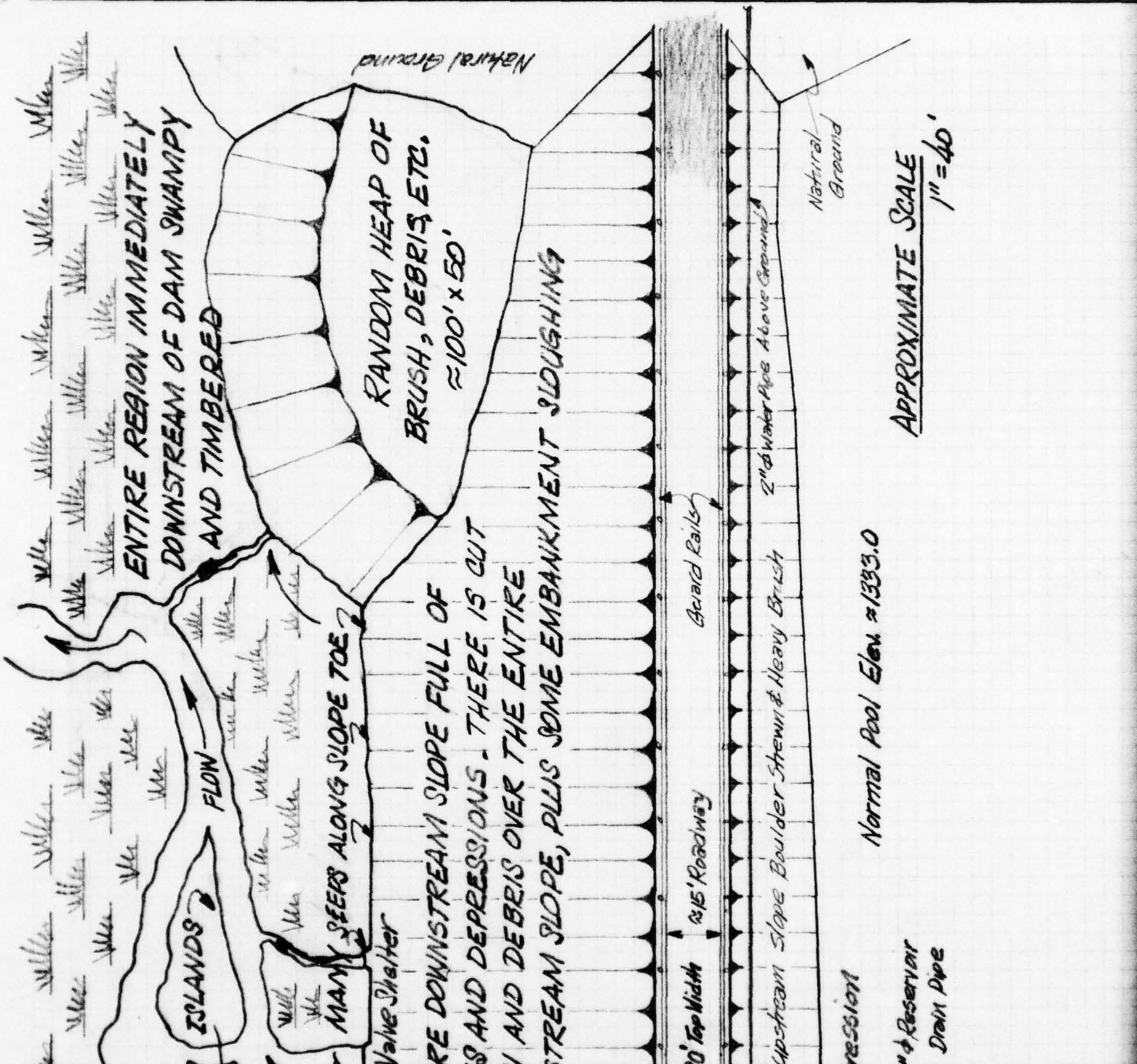
JOB NO: PA-00542

PLATE 3

O'BRIEN & GERE ENGINEERS, INC.

PLATE 4

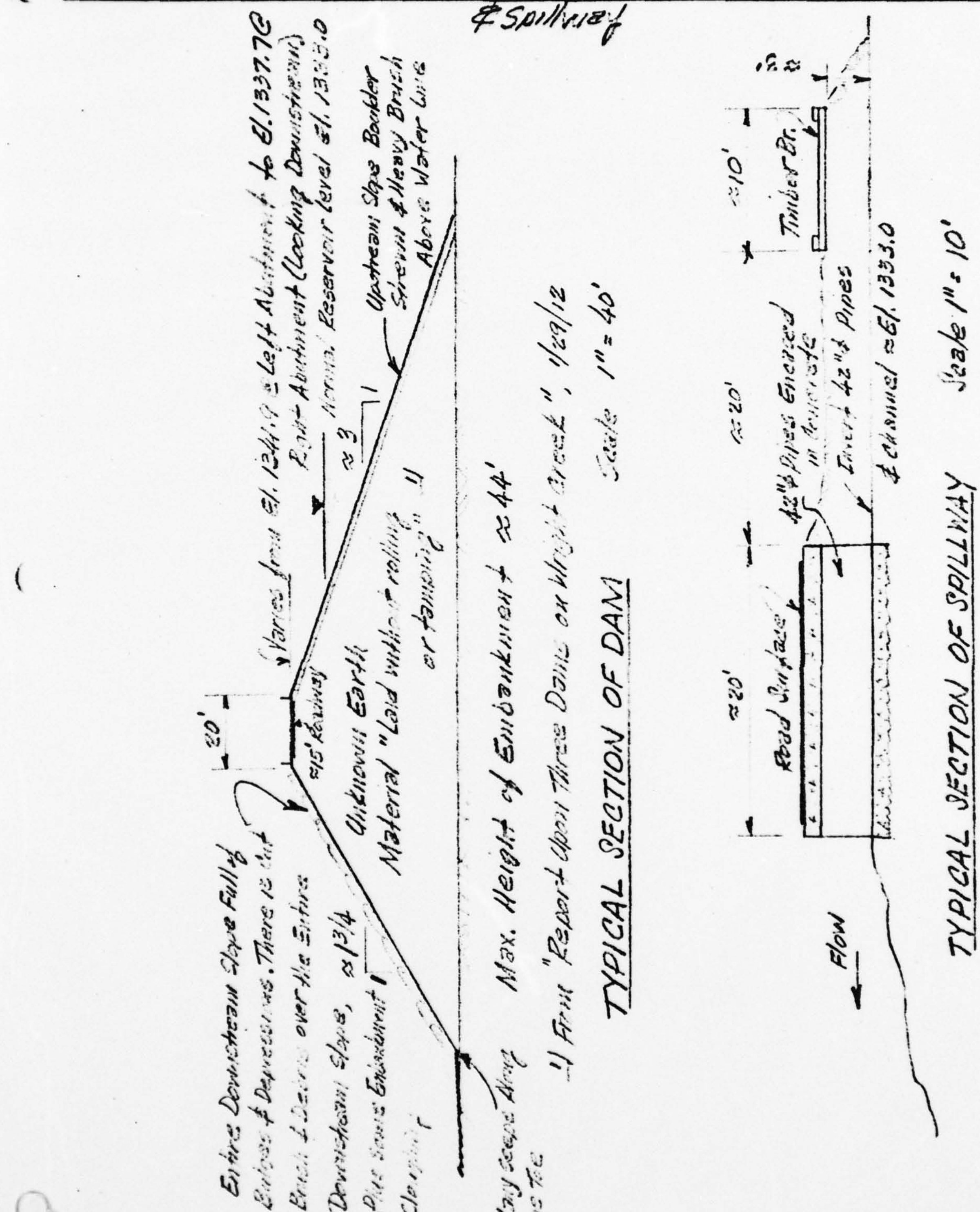
SUBJECT	SHEET	BY	DATE	JOB NO
Penn Lake Dam, Plan View of Dam		JB	2/21/79	PA-00452



O'BRIEN & GERE ENGINEERS, INC.

PLATE 5

SUBJECT	SHEET	BY	DATE	JOB NO
Penn Lake Dam, Cross Section of Emb. & Spillway			2/22/79	



APPENDIX

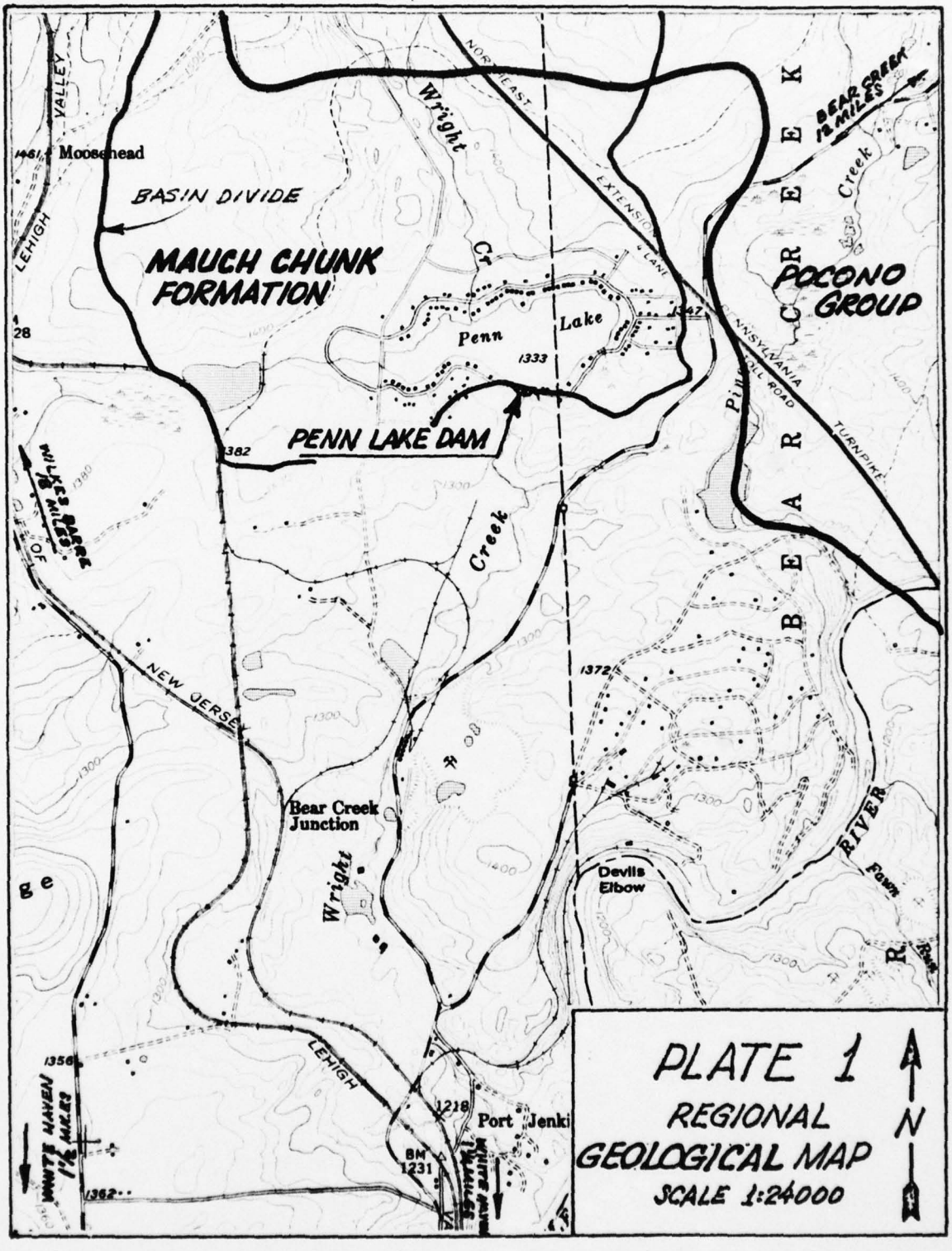
F

Site Geology

SITE GEOLOGY

Penn Lake Dam

Penn Lake is located in a high plateau depression within the glaciated portion of the Appalachian Mountain section of the Valley and Ridge physiographic province. At the site sedimentary units of the predominantly red shales and sandstones of the Mississippian Mauch Chunk formation dip slightly northwest. Some thin deposits of rock debris, remnants of Pleistocene (Wisconsin) glaciation overlie the bedrock formations. No faults on major structural defects are noted in the vicinity of the dam or lake.


Moosehead
BASIN DIVIDE
MAUCH CHUNK FORMATION
LEHIGH VALLEY
Wright Cr
NORTH EAST EXTENSION
BEAR CREEK
BEAR CREEK 12 MILES
POCONO GROUP
Penn Lake
1333
1347
PENN LAKE DAM
382
PENNSYLVANIA TURNPIKE
WILKES BARRE 13 MILES
NEW JERSEY
Creek
1372
Bear Creek Junction
Wright
Devils Elbow
RIVER
Fawn
LEHIGH
1356
1218
Port Jenki
BM 1231
1362
PLATE 1
REGIONAL GEOLOGICAL MAP
SCALE 1:24000
N